# ATom: Observed and Modeled Organic Aerosol Mass Concentrations, 2016-2017

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## Summary

This dataset provides airborne in situ observations of submicron organic aerosol (OA) mass concentrations during the first (mid-2016) and second (early-2017) global deployments of the Atmospheric Tomography Mission (ATom), as well as modeled submicron OA mass concentrations along the flight tracks from global chemistry models that implement a variety of commonly used representations of OA sources and chemistry. In situ observations include non-refractory submicron aerosols measured by the High-Resolution Aerosol Mass Spectrometer (HR-AMS), aerosol volume concentrations measured by the Aerosol Microphysical Properties package (AMP), black carbon mass content measured by the Single Particle Soot Photometer (NOAA SP2), and refractory and non-refractory aerosol composition measured by the Particle Analysis By Laser Mass Spectrometry (PALMS). Both observed and modeled data are provided at a 60-second temporal resolution. The data are provided in netCDF format.

There are 20 data files in netCDF (*.nc) format included in this dataset. All files were converted to netCDF format if the data provider submitted it in a different format.

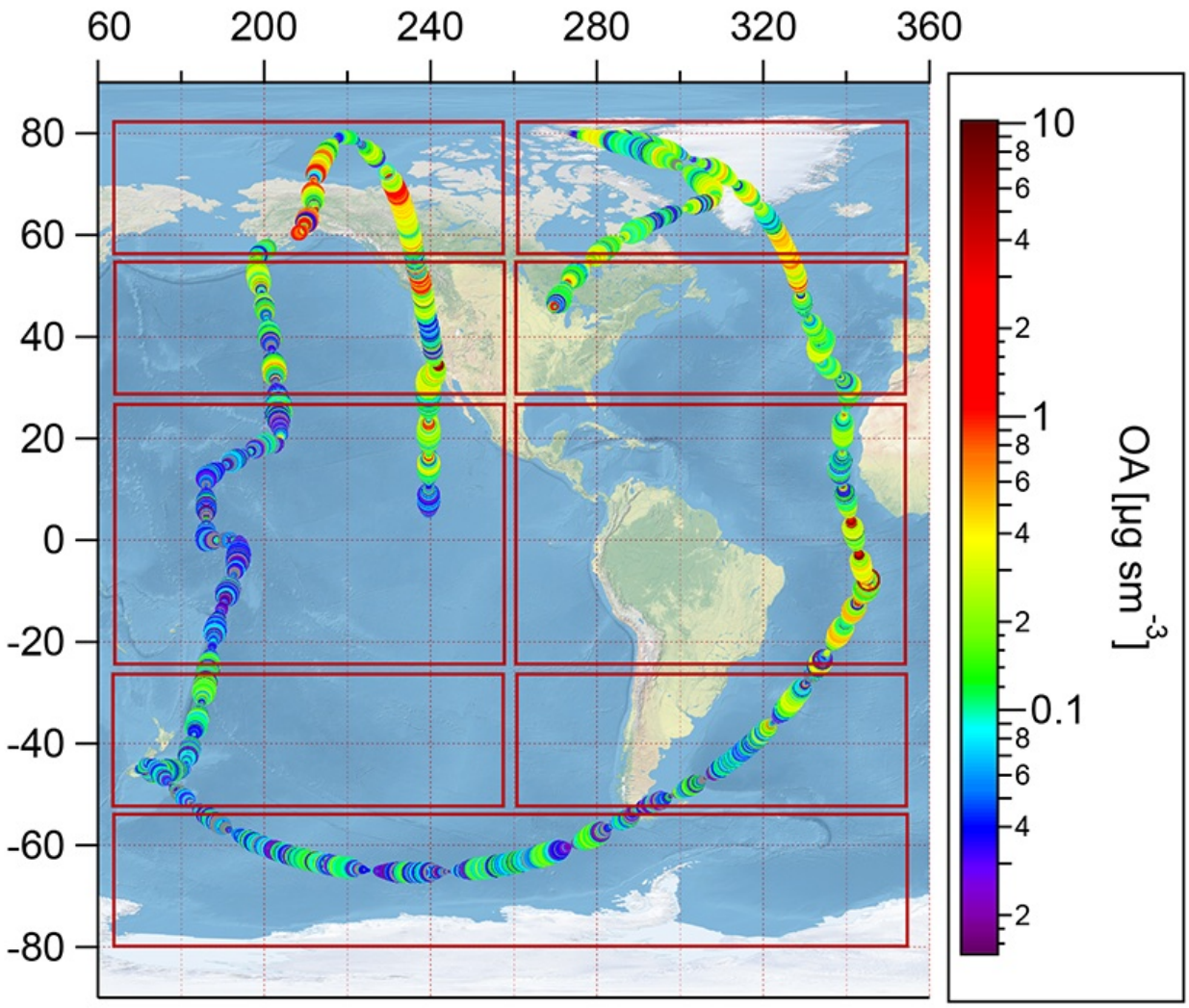


Figure 1. ATom-1 flights during the August 2016 deployment. Red boxes indicate regions used for the latitude averaging of the model results. Source: Hodzic et al. (2020)

## Citation

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## 1. Dataset Overview

This dataset provides airborne in situ observations of submicron organic aerosol (OA) mass concentrations during the first (mid-2016) and second (early-2017) global deployments of the Atmospheric Tomography Mission (ATom), as well as modeled submicron OA mass concentrations along the flight tracks from global chemistry models that implement a variety of commonly used representations of OA sources and chemistry. In situ observations include non-refractory submicron aerosols measured by the High-Resolution Aerosol Mass Spectrometer (HR-AMS), aerosol volume concentrations measured by the Aerosol Microphysical Properties package (AMP), black carbon mass content measured by the Single Particle Soot Photometer (NOAA SP2), and refractory and non-refractory aerosol composition measured by the Particle Analysis By Laser Mass Spectrometry (PALMS). Both observed and modeled data are provided at a 60-second temporal resolution.

**Project:** Atmospheric Tomography Mission

The Atmospheric Tomography Mission (ATom) is a NASA Earth Venture Suborbital-2 mission to study the impact of human-produced air pollution on greenhouse gases and on chemically reactive gases in the atmosphere. ATom deployed an extensive gas and aerosol payload on the NASA DC-8 aircraft for systematic, global-scale sampling of the atmosphere, profiling continuously from 0.2 to 12 km altitude. Around-the-world flights were conducted in

each of four seasons between 2016 and 2018.

**Related Publication**

Hodzic, A., P. Campuzano-Jost, H. Bian, M. Chin, P.R. Colarco, D.A. Day, K.D. Froyd, B. Heinold, D.S. Jo, J.M. Katich, and J.K. Kodros. 2020. Characterization of organic aerosol across the global remote troposphere: a comparison of ATom measurements and global chemistry models. Atmospheric Chemistry and Physics 20:4607–4635. https://doi.org/10.5194/acp-20-4607-2020

**Related Datasets**

Brock, C.A., A. Kupc, C.J. Williamson, K. Froyd, F. Erdesz, D.M. Murphy, G.P. Schill, D.W. Gesler, R.J. Mclaughlin, M. Richardson, N.L. Wagner, and J.C. Wilson. 2019. ATom: L2 In Situ Measurements of Aerosol Microphysical Properties (AMP). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1671

Jimenez, J.L., P. Campuzano-Jost, D.A. Day, B.A. Nault, D.J. Price, and J.C. Schroder. 2019. ATom: L2 Measurements from CU High-Resolution Aerosol Mass Spectrometer (HR-AMS). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1716

Schwarz, J.P., and J.M. Katich. 2019. ATom: L2 In Situ Measurements from Single Particle Soot Photometer (SP2). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1672

Wofsy, S.C., S. Afshar, H.M. Allen, E.C. Apel, E.C. Asher, B. Barletta, et al. 2018. ATom: Merged Atmospheric Chemistry, Trace Gases, and Aerosols. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1581

**Acknowledgments**

This work was supported by NASA Earth Venture Suborbital-2 (grants NNX15AH33A, NNX15AJ23G).

## 2. Data Characteristics

**Spatial Coverage:** global

**Spatial Resolution:** Point (track) measurements

**Temporal Coverage:** 2016-07-29 to 2017-02-22

**Temporal Resolution:** 1 minute

**Study Area:** Latitude and longitude are given in decimal degrees.

| Site | Northernmost Latitude | Southernmost Latitude | Easternmost Longitude | Westernmost Longitude |
|---|---|---|---|---|
| Global | 90 | -90 | 180 | -180 |

**Data File Information**

There are 20 data files in netCDF (*.nc) format included in this dataset. All files were converted to netCDF format if the data provider submitted it in a different format. The files use the original naming scheme of the data provider. With the exception of files for the CESM1-CARMA model and files ending with "SVPOA" for the GC12-REF and GC12-DYN models, there is one ATom-1 and one ATom-2 file per model. See Table 1 for more information.

Table 1. File names and descriptions. See the related publication Hodzic et al. (2020) for details on the model configurations and references.

| File Name | Model | Description |
|---|---|---|
| AEROCOM-ATom1-OAOC_DC8_20160729_R0.nc | AeroCom-II | Model output along the ATom-1 track. Data were originally submitted in the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT) format. |
| AEROCOM-ATom2-OAOC_DC8_20170126_R0.nc | AeroCom-II | Model output along the ATom-2 track. Data were originally submitted in the ICARTT format. |
| ATOM13_CARMA_hs.nc | CESM1-CARMA | Model output along the ATom-1, ATom-2, and Atom-3 tracks. |
| CESM_VBS_waccm_ATom1.nc | CESM2-DYN | Model output along the ATom-1 track. |
| CESM_VBS_waccm_ATom2.nc | CESM2-DYN | Model output along the ATom-2 track. |
| CESM_waccm_ATom1.nc | CESM2-SMP | Model output along the ATom-1 track. |
| CESM_waccm_ATom2.nc | CESM2-SMP | Model output along the ATom-2 track. |
| CESMCARMA1-ATom1-AerosolComposition_DC8_20160729_R0.nc | CESM1-CARMA | Aerosol output along the ATom-1 track. Data were originally submitted in the ICARTT format. |
| ECHAM-HAM-ATOM_2016.nc | ECHAM6-HAM | Model output along the ATom-1 track. |
| ECHAM-HAM-ATOM_2017.nc | ECHAM6-HAM | Model output along the ATom-2 track. |
| GEOS_Chem_10_TOMAS_ATom1.nc | GC10-TOMAS | Model output along the ATom-1 track. |

| File Name | Model | Description |
|---|---|---|
| GEOS_Chem_10_TOMAS_ATom2.nc | GC10-TOMAS | Model output along the ATom-2 track. |
| GEOS_Chem_12_output_for_ATom1_SVPOA.nc | GC12-REF | Model output along the ATom-1 track using semi-volatile primary organic aerosol. |
| GEOS_Chem_12_output_for_ATom12.nc | GC12-REF | Model output along the ATom-1 and ATom-2 tracks. |
| GEOS_Chem_12_with_Hodzic2016_ATom1_SVPOA.nc | GC12-DYN | Model output along the ATom-1 track using semi-volatile primary organic aerosol. |
| GEOS_Chem_12_with_Hodzic2016_for_ATom12.nc | GC12-DYN | Model output along the ATom-1 and ATom-2 tracks. |
| GEOS5_atom1.nc | GEOS5 | Model output along the ATom-1 track. |
| GEOS5_atom2.nc | GEOS5 | Model output along the ATom-2 track. |
| Observations-ATom1-PM1Aerosol_DC8_20160729_R0.nc | - | ATom-1 measurements used in the models. Data were originally submitted in the ICARTT format. |
| Observations-ATom2-PM1Aerosol_DC8_20170126_R0.nc | - | ATom-2 measurements used in the models. Data were originally submitted in the ICARTT format. |

**Data File Details**

The lengths, units, etc. of dimensions and variables are not consistent across data files; the files are provided as originally submitted except for transformation into netCDF format if not submitted in that format.

For the two observations files (i.e., files beginning with the name "Observations"), the instruments and sources for measurements are as follows:

- non-refractory submicron aerosols by the High-Resolution Aerosol Mass Spectrometer (HR-AMS; Jimenez et al., 2019)
- aerosol volume concentrations by the Aerosol Microphysical Properties package (AMP; Brock et al. 2019)
- black carbon mass content by the Single Particle Soot Photometer (NOAA SP2; Schwarz et al. 2019)
- refractory and non-refractory aerosol composition by the Particle Analysis By Laser Mass Spectrometry (PALMS; Wofsy et al. 2018)

Generally, each file contains variable descriptions except for the files GEOS_Chem_10_TOMAS_ATom1.nc and GEOS_Chem_10_TOMAS_ATom2.nc.This information is included in Table 2.

Table 2. Variable names and descriptions for data files GEOS_Chem_10_TOMAS_ATom1.nc and GEOS_Chem_10_TOMAS_ATom2.nc. All aerosol products are output as a 15-bin size distribution.

| Variable | Units | Description |
|---|---|---|
| **State Parameters** | | |
| POINT | | point number |
| FLIGHT | | platform NASA DC-8 |
| YYYMMDD | | date |
| HHMM | UTC | time |
| LAT | degrees north | latitude along the flight track |
| LON | degrees east | longitude along the flight track |
| PRESS | mbar | atmospheric pressure along the flight track |
| Temp | K | ambient temperature |
| **Standard Model Output** | | |
| NO | kg $kg^{-1}$ | nitrous oxide |
| O3 | kg $kg^{-1}$ | ozone |
| PAN | kg $kg^{-1}$ | peroxyacetylnitrate |
| CO | kg $kg^{-1}$ | carbon monoxide |
| ISOP | kg $kg^{-1}$ | isoprene |
| HNO3 | kg $kg^{-1}$ | nitric acid |
| H2O2 | kg $kg^{-1}$ | water peroxide |
| ACET | kg $kg^{-1}$ | acetone |

| Variable | Units | Description |
|---|---|---|
| **State Parameters** | | |
| MVK | kg $kg^{-1}$ | methyl vinyl ketone |
| MACR | kg $kg^{-1}$ | methacrolein |
| C3H8 | kg $kg^{-1}$ | ethane |
| C2H6 | kg $kg^{-1}$ | methane |
| DMS | kg $kg^{-1}$ | dimethylsulfide |
| SO2 | kg $kg^{-1}$ | sulfur dioxide |
| SO4 | kg $kg^{-1}$ | fine particle sulfate from base model |
| SO4s | kg $kg^{-1}$ | coarse particle sulfate from base model |
| MSA (particle) | kg $kg^{-1}$ | methansulfonic acid |
| NH3 | kg $kg^{-1}$ | ammonia |
| NH4 (g) | kg $kg^{-1}$ | ammonium |
| NIT (aerosol) | kg $kg^{-1}$ | fine particle nitrate |
| NITs (aerosol) | kg $kg^{-1}$ | coarse particle nitrate |
| BCPI | kg $kg^{-1}$ | black carbon, hydrophilic |
| OCPI | kg $kg^{-1}$ | organic carbon, hydrophilic |
| BCPO | kg $kg^{-1}$ | black carbon, hydrophobic |
| OCPO | kg $kg^{-1}$ | organic carbon, hydrophilic |
| SALA | kg $kg^{-1}$ | fine sea salt aerosol |
| SALC | kg $kg^{-1}$ | coarse sea salt aerosol |
| CH3Br | kg $kg^{-1}$ | methyl bromine |
| ISOPN | kg $kg^{-1}$ | isoprene nitrate |
| NO2 | kg $kg^{-1}$ | nitric oxide |
| NO3 | kg $kg^{-1}$ | nitrate radical |
| HNO2 | kg $kg^{-1}$ | nitrous acid |
| DST1 | kg $kg^{-1}$ | dust aerosol; Ref = 0.7 microns |
| DST2 | kg $kg^{-1}$ | dust aerosol; Ref = 1.4 microns |
| DST3 | kg $kg^{-1}$ | dust aerosol; Ref = 2.4 microns |
| DST4 | kg $kg^{-1}$ | dust aerosol; Ref = 4.5 microns |
| **Microphysical Model Output** | | |
| Mass per particle bin edges | kg | 1.60E-20, 6.40E-20, 2.56E-19, 1.02E-18, 4.10E-18, 1.64E-17, 6.55E-17, 2.62E-16, 1.05E-15, 4.19E-15, 1.68E-14, 6.71E-14, 2.68E-13, 1.07E-12, 3.44E-11, 1.10E-9 |
| Approx. Bin MidPoint Diameter | nm | 3.3, 5.2, 8.2, 13.0, 20.7, 33.8, 52.1, 83.7, 131, 208, 331, 525, 834, 1871, 5941 |
| H2SO4 | µg $m^{-3}$ | sulfuric acid |
| NK1..NK15 | $cm^{-3}$ | total aerosol number assuming an internally mixed population |
| SF1..SF15 | $cm^{-3}$ | sulfate aerosol |
| SS1..SS15 | $cm^{-3}$ | sea salt aerosol |
| ECIL1-ECIL15 | $cm^{-3}$ | black carbon, internally mixed |
| ECOB1-ECOB15 | $cm^{-3}$ | black carbon, externally mixed |
| OCIL1-OCIL15 | $cm^{-3}$ | organic aerosol, hydrophilic |

| Variable | Units | Description |
|---|---|---|
| **State Parameters** | | |
| OCOB1-OCOB15 | $cm^{-3}$ | organic aerosol, hydrophobic |
| DUST1-DUST15 | $cm^{-3}$ | dust aerosol |
| AW1-AW15 | $cm^{-3}$ | aerosol water |

## 3. Application and Derivation

Organic aerosols and sulfate are major contributors by mass to submicron aerosols in the remote troposphere, and the spatial distribution and properties of submicron organic aerosol are among the key sources of uncertainty in understanding aerosol effects on climate. These data provide an extensive characterization of organic aerosol mass concentrations and their level of oxidation in the remote atmosphere. See Hodzic et al. (2020) for more information.

## 4. Quality Assessment

Hodzic et al. (2020) provides the accuracy and precision of each measurement and the performance of each model.

## 5. Data Acquisition, Materials, and Methods

Hodzic et al. (2020) provides the details of each measurement and the configuration of each model.

## 6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

ATom: Observed and Modeled Organic Aerosol Mass Concentrations, 2016-2017

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

## 7. References


Brock, C.A., A. Kupc, C.J. Williamson, K. Froyd, F. Erdesz, D.M. Murphy, G.P. Schill, D.W. Gesler, R.J. Mclaughlin, M. Richardson, N.L. Wagner, and J.C. Wilson. 2019. ATom: L2 In Situ Measurements of Aerosol Microphysical Properties (AMP). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1671

Hodzic, A., P. Campuzano-Jost, H. Bian, M. Chin, P.R. Colarco, D.A. Day, K.D. Froyd, B. Heinold, D.S. Jo, J.M. Katich, and J.K. Kodros. 2020. Characterization of organic aerosol across the global remote troposphere: a comparison of ATom measurements and global chemistry models. Atmospheric Chemistry and Physics, 20:4607-4635. https://doi.org/10.5194/acp-20-4607-2020

Jimenez, J.L., P. Campuzano-Jost, D.A. Day, B.A. Nault, D.J. Price, and J.C. Schroder. 2019. ATom: L2 Measurements from CU High-Resolution Aerosol Mass Spectrometer (HR-AMS). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1716

Schwarz, J.P., and J.M. Katich. 2019. ATom: L2 In Situ Measurements from Single Particle Soot Photometer (SP2). ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1672

Wofsy, S.C., S. Afshar, H.M. Allen, E.C. Apel, E.C. Asher, B. Barletta, J. Bent, H. Bian, B.C. Biggs, D.R. Blake, N. Blake, I. Bourgeois, C.A. Brock, W.H. Brune, J.W. Budney, T.P. Bui, A. Butler, P. Campuzano-Jost, C.S. Chang, M. Chin, R. Commane, G. Correa, J.D. Crounse, P. D. Cullis, B.C. Daube, D.A. Day, J.M. Dean-Day, J.E. Dibb, J.P. DiGangi, G.S. Diskin, M. Dollner, J.W. Elkins, F. Erdesz, A.M. Fiore, C.M. Flynn, K.D. Froyd, D.W. Gesler, S.R. Hall, T.F. Hanisco, R.A. Hannun, A.J. Hills, E.J. Hintsa, A. Hoffman, R.S. Hornbrook, L.G. Huey, S. Hughes, J.L. Jimenez, B.J. Johnson, J.M. Katich, R.F. Keeling, M.J. Kim, A. Kupc, L.R. Lait, J.-F. Lamarque, J. Liu, K. McKain, R.J. Mclaughlin, S. Meinardi, D.O. Miller, S.A. Montzka, F.L. Moore, E.J. Morgan, D.M. Murphy, L.T. Murray, B.A. Nault, J.A. Neuman, P.A. Newman, J.M. Nicely, X. Pan, W. Paplawsky, J. Peischl, M.J. Prather, D.J. Price, E.A. Ray, J.M. Reeves, M. Richardson, A.W. Rollins, K.H. Rosenlof, T.B. Ryerson, E. Scheuer, G.P. Schill, J.C. Schroder, J.P. Schwarz, J.M. St.Clair, S.D. Steenrod, B.B. Stephens, S.A. Strode, C. Sweeney, D. Tanner, A.P. Teng, A.B. Thames, C.R. Thompson, K. Ullmann, P.R. Veres, N. Vieznor, N.L. Wagner, A. Watt, R. Weber, B.B. Weinzierl, P.O. Wennberg, C.J. Williamson, J.C. Wilson, G.M. Wolfe, C.T. Woods, and L.H. Zeng. 2018. ATom: Merged Atmospheric Chemistry, Trace Gases, and Aerosols. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1581